



Towards assessing Product/Service-Systems (PSS) within the Danish maritime industry: A PSS positioning map

Hsuan, Juliana; Andersen, Jakob Axel Bejbro; Bey, Niki; McAloone, Tim C.; Mougaard, Krestine; Neugebauer, Line Maria

Published in:
Proceedings of the 4th Joint World Conference on Production & Operations Management / 19th International Annual EurOMA Conference

Publication date:
2012

[Link back to DTU Orbit](#)

Citation (APA):
Hsuan, J., Andersen, J. A. B., Bey, N., McAloone, T. C., Mougaard, K., & Neugebauer, L. M. (2012). Towards assessing Product/Service-Systems (PSS) within the Danish maritime industry: A PSS positioning map. In *Proceedings of the 4th Joint World Conference on Production & Operations Management / 19th International Annual EurOMA Conference*

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Towards assessing Product/Service-Systems (PSS) within the Danish maritime industry: A PSS positioning map

*Juliana Hsuan
Copenhagen Business School
Department of Operations Management
Solbjerg Plads 3, DK-2000 Frederiksberg, Denmark*

*Jakob B. Andersen
Technical University of Denmark
Department of Mechanical Engineering
Niels Koppels Allé, Bldg. 404, DK-2800 Kgs. Lyngby, Denmark*

*Niki Bey
Technical University of Denmark
Department of Mechanical Engineering
Niels Koppels Allé, Bldg. 404, DK-2800 Kgs. Lyngby, Denmark*

*Tim McAloone
Technical University of Denmark
Department of Mechanical Engineering
Niels Koppels Allé, Bldg. 404, DK-2800 Kgs. Lyngby, Denmark*

*Krestine Mougaard (kmou@mek.dtu.dk)
Technical University of Denmark
Department of Mechanical Engineering
Niels Koppels Allé, Bldg. 404, DK-2800 Kgs. Lyngby, Denmark*

*Line Neugebauer
Technical University of Denmark
Department of Mechanical Engineering
Niels Koppels Allé, Bldg. 404, DK-2800 Kgs. Lyngby, Denmark*

Abstract

In response to requirements resulting from a changing business landscape from solely physical-product-based value creation towards performance-based value creation, this paper presents a questionnaire-based matrix, the PSS Categorization Matrix, that is developed in order to help organizations find their position in terms of the balance between product-related and service-related activities. Judging from a workshop carried out with companies from the maritime industry and researchers in the area, the approach seems promising, but requires improvements on questionnaire and Matrix .

These need to incorporate further improvements regarding the factor of time and the applicability related to product/service portfolios, as opposed to single product/services. The authors already plan further research on the identified issues.

Keywords: Product/Service-Systems, Danish maritime industry, PSS Categorization

Introduction

As the business landscape is changing from solely *physical product-based* value creation towards *performance-based* value creation, many companies are challenged in adapting their business models to accommodate this. Obtaining a higher share of revenue from service activities is seen by many companies in the Danish maritime industry as a way forward. Rather than trying to sell more products and/or improved products, many companies are offering integrated systems of products and services. This approach is fundamental to augmenting the utility of the PSSs (Product/Service-Systems) throughout the whole product/service life cycle. As an example for a PSS approach in the maritime industry, a producer of main engines and generator sets offers complete propulsion packages together with the engines and after sales services such as repair, spare parts supply, retrofitting, recycling and monitoring of the engines.

This paper is created within the frame of an innovation consortium in the Danish maritime industry called PROTEUS (PROduct/service-system Tools for Ensuring User-oriented Service). One of the goals of the consortium is to expand the PSS tool box by creating normative methods that can be applied in the industry. Many Danish companies see the advantages of PSS but lack an overview of the possibilities for PSS within their companies and a means for strategic positioning and planning with regard to the balance between product sales and service activities. Many companies also have little guidance for handling strategic decisions about their PSS. Hence our research questions are: What integrated product and service elements should the companies consider in order to create as much value as possible, both for themselves and also for the Danish maritime industry as a whole? What kinds of managerial tools can be developed to facilitate such decisions?

Applying an approach of “first having to know where you are and what potential options there are” and then “deciding upon, which way to go”, we suggest in this paper a means to support exactly this: A matrix-based “map” that allows organizations to determine a “current position” in terms of product/service activities and that also provides a collection of main factors that have an influence on that position. In combination, map and factors can be used to explore options for dedicated influencing of selected factors in order to reach a certain desired position on the map.

Literature Review

Product and Service Systems

The PSS field is an emerging research area. Particularly research on both the *assessment* of the PSS *structure* and PSS *strategy* is immature. PSS literature focuses mainly on describing the dimensions and elements of Product/Service-Systems, and to a much lower

degree on the definitions and research approaches for academics and practitioners to *conceptualize* PSS. In order to provide a categorization of PSS, we conducted a comprehensive literature review on PSS (e.g., Baines et al., 2007; Mont, 2004; Tan, 2010; Tan and McAloone, 2006; McAloone et al., 2011; Lee et al., 2011), service systems (e.g., Chesbrough, 2011; Voss and Hsuan, 2009; Bask et al., 2010; Roth and Menor, 2003; Metters and Vargas, 2000; Pekkarinen and Ulkuniemi, 2008) and product systems (e.g., Meyer and Lehnerd, 1997; Mikkola, 2006; Schilling, 2000; Garud and Kumaraswamy, 1995; Baldwin and Clark, 1997; Ulrich, 1995).

Product Systems

Product systems can be portrayed from the product architecture modularity literature, where the distinctions between modular and integral product architectures are well articulated in terms of the following characteristics: component standardization, system decomposition, component sharing, product variations, degree of customization, and component costs (Figure 1). Modular product architecture designs intentionally create independence between components by standardizing interface specifications, from which components can be disassembled and recombined into new configurations. Modular product architectures provide the foundation for flexible platforms where high product variations and customization can be realized. This is possible because changes in one component do not lead to changes in other components, and as such mixing-and-matching of components is enabled. Due to standardization, modular components tend to compete on price. The motivation behind this strategy is to gain cost savings through economies of scale from component commonality, inventory, logistics, as well as to introduce technologically improved products more rapidly. It also allows the firm to make product changes easily such as upgrades, add-ons, product line extensions, and cosmetic adaptations. This, in turn, enables firms to make use of customer feedback and alter their systems accordingly by substituting some components while retaining others. Examples of products with modular product architectures include LEGO toys, bicycles, elevators, mobile phones, etc.

Conversely, with integral product architectures modifications to any one component cannot be done without the redesign or reconfiguration of the other components. Performance is often the key objective. This can be prohibitively costly for complex systems. Examples of integral systems include satellites, Formula One cars, human body, etc.

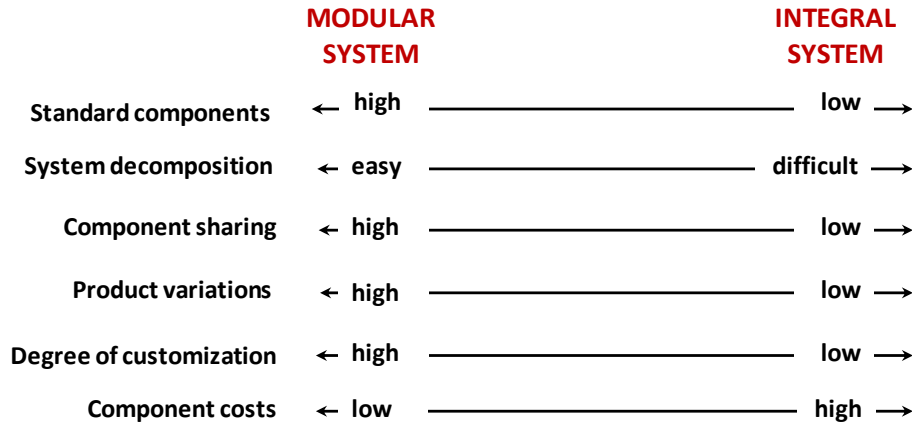


Figure 1. Characteristics of product systems.

Service Systems

Service systems differ from product systems in many ways. Services are essentially activities that are essentially intangible and perishable. The production, delivery and consumption of services take place at the same time. Service systems should be designed in a way that creates consistent service offerings that achieve the strategic vision of the organization. Roth and Menor (2003) mention three interrelated elements that a service system design should consider: 1) strategic service design choices, 2) service delivery system execution, renewal, and assessment, and 3) customer perceived value of the total service concept.

Service systems can be portrayed in a continuum, ranging between specialized to standard systems (Figure 2). Standard service systems have a high number of standard elements (e.g., generic, mass services), high level of replicability (i.e. easily copied), low level of customization (i.e. customers cannot personally change the nature of the services offered), low consulting portion and specialization (i.e. low involvement of professional services), and low cost for the customers. Examples of standard service systems include fast food restaurants, online banking, schools, hotels, airlines, etc.

Specialized service systems, on the other hand, have a low number of standard elements (e.g. service shops and professional services), low level of replicability (i.e. imitation by competitors can be difficult), high levels of customization, consulting portion, specialized elements (i.e. delivered services are per customer's needs), and can be expensive for the customers. Examples of specialized service systems include architecture firms, surgery, law firms, consulting firms, etc.

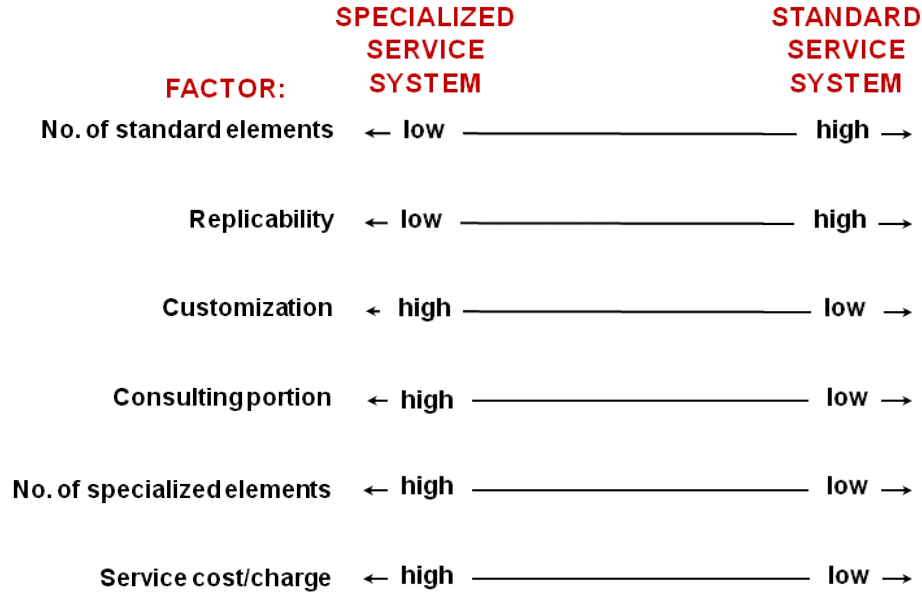


Figure 2. Characteristics of service systems.

Research Methodology

Although our current investigation is exploratory, we seek to build theory. In doing so, we identify key variables, linkages between variables, and ‘why’ these relationships exist (Voss, 2009). Based on the extensive literature review on PSS, product systems and service systems, we introduce a 2x2 matrix called “PSS Categorization Matrix” that allowed us to create a classification of four PSS types. The matrix has two dimensions: one being “product system”, the other being “service system”. As shown in Figures 1 and 2, respectively, the product system dimension encompasses the following factors: component standardization, system decomposition, component sharing, product variations, degree of customization, and component costs. The service system dimension encompasses the following factors: standardization, replicability, customization, consulting portion, specialization, and service costs.

Categorizing Product Service Systems

From the stream of literature just described, we deductively build a conceptual framework to characterize and classify PSSs. The PSS Categorization Matrix (Figure 3) distincts four types of PSSs that are derived from the combination of two types of product systems – “modular” and “integral” – and two types of service systems – “standard” and “specialized”. These four types correspond to four quadrants in the PSS Categorization Matrix and are explained below.

Quadrant I: A “PSS1” type is the combination of specialized service system and integral product system. A product system may be difficult to decompose into distinct, simpler portions due to, for instance, certain complexities embedded in it or due to a high amount of proprietary technology. Such integral product systems tend not to share components and comprise only few product variations where the degree of customization is limited. Often, specialized one-off services are offered in order to cater to customers’ special needs where close collaboration with the customer is essential. An example of a PSS1

type is “consulting in R&D sourcing strategies”. In the maritime context, shipowners might have to work very closely with specialized suppliers in order to develop sophisticated technologies to reduce emissions. Another example of this is when an engine manufacturer sells an engine together with tailor-made operation and maintenance activities.

Quadrant II: A PSS2 type of system exists when an integral product system is served with standard services. Such a combination describes complex product systems that are entirely developed by the firm that is vertically integrated. Here, the customer (e.g. a shipowner) only needs to seek for generic services. For example, coordination of generic spare parts for complex ships (such as cruise ships) can be carried out without close collaboration with the concrete customer. A different type of PSS2 can be seen in the case of a producer of coating systems (incl. paints) who may have standardized the process of applying coating system layers. After the last layer of coating has been applied, the finished coating system can be considered a fully integral product.

Quadrant III: A PSS3 type of system describes the combination of modular product system that is serviced with standard services. This situation comprises loosely coupled product systems where the embedded components can be (out)sourced from many suppliers. The standardized nature of the components means that no tailor-made services are required. For example, the maintenance and repair of galleys in bulk carriers (i.e. a modular system comprised of stove, refrigerators, sinks, etc.) does not require specialized skills and can be delivered by many third-party service providers. Another example are low-pressure fire fighting systems that are modular and made up of standardized parts. Such a simplistic system is relatively easy for the crew to repair, thus the service offers have for most parts been reduced to an annual service check, where the service technician runs a standardized system check.

Quadrant IV: A PSS4 type of system is given when a modular product system is serviced with specialized services. Such a combination describes loosely coupled product systems with short product life cycles where there are continuous upgrades that are coupled with incremental innovations. The services provided to such systems have to be tailored to that particular system. An example of a PSS4 type may be software upgrades for navigation systems or – in the maritime context – exhaust gas cleaning installations, so-called “scrubbers”; a retrofit product/system which per definition is modular. The design and installation service of such solutions is highly specialized for the individual ship and shipowner.

Service System	standard	II Standard service Integral product PSS2	III Standard service Modular product PSS3
	specialized	I Specialized service Integral product PSS1	IV Specialized service Modular product PSS4
		integral	modular
		Product System	

Figure 3. PSS Categorization Matrix

Operationalization of the PSS Categorization Matrix

In order to operationalize the Matrix, the authors assigned a normative range to each of the factors (mentioned in Figure 1 and 2) and then implemented the factors and ranges in a simple questionnaire worksheet. Questionnaire and Categorization Matrix were tested in a workshop setting with about 20 participants covering senior managers of companies, Ph.D. students, master students, and academic staff. After filling out the worksheet in private, the participants were asked to plot the results on to the matrix in plenary incl. them explaining their choices. Participants had also been given a template with the “ideal” answers for a given solution, allowing them to compare these with their own responses. This helped the authors identify potential areas for improvement of the questionnaire and the “translation process” of plotting the results onto the Matrix.

Testing the Framework with Case Companies

Description of case companies

The 12 case companies are globally operating companies in the maritime industry. They all have departments in Denmark but not all are originated there. The companies supply a wide variety of products and services for all major ship types. The companies vary greatly on aspects of size, resource availability, development and business strategies as well as product and service range, but common for them all is the ambition to create greater revenue on after market and services.

Data collection

The data collected for this research was obtained in the course of one of the regular half-year meetings in the consortium where representatives of the participating 12 companies of the PROTEUS project meet for one day for an exchange of status and knowledge. The

PSS Categorization Matrix was introduced as a means for the participating companies to get insight into the modularity of their companies' products and services. The participants were also introduced to a questionnaire developed to correlate to the four different PSS types of the PSS Categorization Matrix (see Figure 3). It was pointed out that this was a first test of questionnaire and matrix.

Allowing for facilitating and observation, the company representatives were grouped together with a number of researchers from the Technical University of Denmark and Copenhagen Business School which took part in the exercise to get further insight into the usability of the model. In this way, the questionnaires were answered in groups of two or three participants which ensured discussion before answering the questions. This procedure enabled the researchers at the same time to observe and evaluate the usability of the questionnaire – while not aiming at influencing the answers at all.

After all groups had filled out their questionnaire, one group's results were discussed in plenum and plotted into the PSS Categorization Matrix. This allowed the company representatives to gain insights and also to comment on the use of questionnaire and matrix including implications of the results. This discussion worked as an immediate evaluation of the overall approach.

Discussion and Future Research

As one example, the results of an engine manufacturer suggest that they deal with platform-based modular products that are supported by standard services. However, there seem to be very low degrees of customization and product variations. Furthermore, although replicability of services is quite high (for both standard and specialized services), there is also a high amount of consulting involved.

We won't discuss other concrete company results from the matrix here, since emphasis in the data collection had been more on testing of how questionnaire and matrix worked for the companies rather than on producing valid results for the companies.

Our preliminary results show that the mapping exercise guided the participating managers in evaluating the activities of their companies with critical lenses, because they had to consider products and services together as an integrated system. This was challenging for the managers who otherwise only dealt with either products or services. However, once the PSSs were mapped – and in that sense a “current position” been identified a discussion of “where to go” came up and we were able to relate them to other stakeholders' (i.e. competitors', ship owners', suppliers' and customers') PSSs, and discuss competitive strategies. This guiding function of the approach is very immature but was seen as very useful, under the condition that it can produce concrete and valid advice.

The discussion also brought up several issues that may be relevant to include in a further development of the approach: For instance, “changes over time”, are not supported, yet; while the matrix allows mapping of situations as they are in one point of time, dynamic changes due to change of cost, processes/technologies and various additional factors over a life cycle are not reflected yet. An example are the whole set of new requirements coming up related to so-called “slow steaming”, i.e. slower travelling in order to save fuel and reduce emissions. Also, it turned out that both single product/service offerings can be mapped but also collective offerings – with different positions and potential ways to go.

A view on a whole portfolio of a company, however, is so far not supported in the approach. Finally, general applicability vs. specific aspects of applicability in the maritime industry have not been addressed.

Our research contributes to literature and management in many ways. Although our focus is on the maritime industry, the conceptualization and categorization of PSS can be applied to other industries as well. Because PSS is an emerging research topic and also an important concept for the Danish companies, we introduced a tool, the PSS Categorization Matrix that can guide the companies in clarifying their current stage in the PSS development and its future directions, and in this way serve as a positioning map. The matrix is also a means that enhances consensus as it brings experience from technology/product designers and service managers together to make integrated decisions.

Research-wise, the matrix bridges service design to product design management. Our next step is to carry out a larger scale data collection with all the project partner companies in the Danish maritime industry.

Conclusions

This paper presented an approach of a questionnaire-based PSS Categorization Matrix that was developed to be used as a positioning map for companies in order to determine their individual balance between products and services in their offerings. The questionnaire and matrix are at a preliminary development stage, and results from a workshop indicate a certain degree of applicability but also a number of potential further improvements, including the specific questions in the questionnaire and the necessity to incorporate in the overall approach the aspect of changes over time and a way of dealing with company portfolios rather than single product/service offerings. A larger data collection activity is planned to further investigate and deal with these issues and bring the approach further on its way towards a valuable means to make assessments of current PSS activities and to obtain input for a given organization on which ways to go forward.

References

- Baines, T.S., Lightfoot, H.W., Evans, S., Neely, A.D., Greenough, R.M., Peppard, J., Roy, R., Shehab, E., Braganza, A., Tiwari, A., Alcock, J.R., Angus, J., Basti, M., Cousens, A., Irving, P., Johnson, M., Kingston, J.C., Lockett, H.L., Martinez, V., Tranfield, D.R., Walton, I.M. and Wilson, H. (2007), "State-of-the-art in product service systems", *Journal of Engineering Manufacture*, Part B, pp. 1543-1551.
- Baldwin, C.Y. and Clark K.B. (1997), "Managing in an age of modularity", *Harvard Business Review*, September-October, Vol. 75, No. 5, pp. 84-93.
- Bask, A., Lipponen, M., Rajahonka, M. and Tinnilä, M. (2010), "The concept of modularity: diffusion from manufacturing to service production", *Journal of Manufacturing Technology Management*, Vol. 21, No. 3, pp. 355-375.
- Chesbrough, H. (2011), *Open service innovation – Rethinking your business to grow and compete in a new era*, Jossey-Bass.
- Garud, R. and Kumaraswamy, A. (1995). "Technological and Organizational Designs for Realizing Economies of Substitution", *Strategic Management Journal*, Vol. 16, special issue, pp. 93–109.
- Lee, H. J., Shin, D. I., Hing Y. S. and Kim Y. S. (2011), "Business model design methodology for innovative product.service systems: A strategic and structured approach", Working Paper, Dept. of Ind. Eng., Seoul Nat. Univ., Seoul, South Korea.

- McAloone C. T., Mougaard K. Neugebauer M. L., Nielsen A. T, Bey, N. (2011), "Orthogonal views on Product/Service system Design in an entire industry branch", Proceedings of ICED11 – International Conference on Engineering Design, August 15-18, Denmark, Copenhagen.
- Meyer, M.H. and Lehnerd, A.P. (1997), *The Power of Product Platforms*. New York, NY: The Free Press.
- Metters, R. and Vargas, V. (2000), "A topology of de-coupling strategies in mixes services", *Journal of Operations Management*, Vol. 18, pp. 663-682.
- Mikkola, J.H. (2006), "Capturing the degree of modularity embedded in product architectures", *Journal of Product Innovation Management*, Vol. 23, pp. 128-146.
- Mont, O. (2004), *Product-service systems: Panacea or Myth?* The international Institute for Industrial Environmental Economics. Lund, Lund University. PhD dissertation.
- Pekkarinen, S. and Ulkuniemi, P. (2008), "Modularity in developing business services by platform approach", *The International Journal of Logistics Management*, Vol. 19, No. 1, pp. 84-103.
- Roth, A.V. and Menor, L.J. (2003), "Insights into service operations management: A research agenda", *Production and Operations Management*, Vol. 12, No. 2, pp. 145-164.
- Schilling, Melissa A. (2000), "Toward a General Modular Systems Theory and Its Application to Interfirm Product Modularity", *Academy of Management Review*, Vol. 25, No. 2, pp. 312–334.
- Tan, A. (2010), *Service-Oriented Product Development Strategies*, Department of Management Engineering, Kgs. Lyngby, The Technical University of Denmark. PhD thesis.
- Tan, A.R. and McAloone, T.C. (2006), "Characteristics of Strategies in Product/Service-System Development", Proceedings of International Design Conference - DESIGN 2006, Dubrovnik, Croatia.
- Tukker, A. and Tischner, U. (2006), *New Business for Old Europe - Product-Service Development, Competitiveness and Sustainability*, Greenleaf Publishing.
- Ulrich, K.T. (1995), "The role of product architecture in the manufacturing firm", *Research Policy*, Vol. 24, pp. 419-40.
- Voss, C. (2009), "Case research in operations management", in C. Karlsson (Ed.), *Researching Operations Management*, New York and London: Routledge, pp. 163-195.
- Voss, C. A. and Hsuan, J. (2009), "Service Architecture and Modularity", *Decision Sciences*, Vol. 40, No. 3, pp. 541-569.